

UNITED STATES PATENT OFFICE

2,350,709

ABSCISSION RETARDING COMPOSITION
AND METHOD FOR USING THE SAMEJames F. Adams, Wilmington, Del., assignor to
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Serial No. 440,756

8 Claims. (Cl. 47—58)

This invention relates to improvements in methods for retarding abscission of those parts of growing plants which tend to become abscised at various stages during growth of the plants, and also to improvements in abscission retarding compositions.

As is known, leaves, buds, flowers, fruits and vegetables often become prematurely abscised from growing plants. This phenomenon is caused by development of abscission layers or cellular structures which permit dropping prior to maturity of the plant part affected. Fruit drop prior to or during normal harvest is a source of substantial loss to growers.

The object of this invention is to provide improvements with respect to retardation or prevention of abscission of parts of growing plants. More particular objects of the invention are provision of compositions and methods for using the same which retard growth of abscission layers in the stems of fruit such as pomes and particularly apples, citrus, nuts, berries and vegetables such as pepo.

I have found that compositions comprising, in particular proportions, two classes of materials—namely (A) certain water-soluble alkyl phenol sulfonates and mixtures thereof, and (B) naphthalene acetic acids and certain related compounds—possess properties and characteristics which retard abscission of those parts of plants which tend to become abscised at various stages during growth of the plant.

With regard to nature of the sulfonate constituents of the compositions used in carrying out the invention, more particularly these sulfonates are water-soluble long chain alkyl phenol sulfonates such as those containing at least 10 carbon atoms in the alkyl group. Desirably, the sulfonate components are water-soluble alkyl phenol sulfonates containing 10 to 30 carbon atoms in the alkyl group, such sulfonates preferably containing a single higher alkyl group having 10 to 30 carbon atoms. In the usual practice of the invention, I employ water-soluble alkyl phenol sulfonates containing 12 to 23 carbon atoms in the alkyl group, and more particularly, the alkyl group of such sulfonates contains 12 to 19 carbon atoms. The sulfonates are ordinarily water-soluble alkali metal salts, e. g. alkyl phenol sodium sulfonates. The alkyl group of any particular sulfonate is desirably derived from a petroleum distillate such as kerosene. These materials are preferably mixtures of the indicated sulfonates, and are especially mixtures of long chain mono-alkyl derivatives of phenol sodium

mono-sulfonate in which the long chain alkyl groups are derived from kerosene and related petroleum distillates.

According to the preferred embodiments of the invention, the sulfonate constituents of the abscission retarding compositions used are those of a group of materials consisting of a mixture comprising inorganic salt or salts, such as alkali metal sulfates, e. g. sodium sulfate, and about 40% by weight of the above described water-soluble alkyl phenol sulfonates.

The sulfonate materials of the compositions of the invention, especially the indicated sulfonate mixtures, are obtainable by chlorinating a hydrocarbon mixture having an average carbon content of 10 to 30 carbon atoms, e. g. kerosene, condensing the chlorinated hydrocarbon mixture with a phenol, in the presence of aluminum chloride or zinc chloride, sulfonating the mixture of alkyl phenols thus produced to obtain a mixture of alkyl phenol sulfonic acids, and neutralizing alkyl phenol sulfonic acids, e. g. by sodium hydroxide, to form an aqueous solution containing inorganic sulfates in addition to alkyl phenol sulfonates. By drying such mass, after adjustment of the inorganic sulfate content if desired, there is obtained a dry product which is a mixture of inorganic sulfate and alkyl aromatic sulfonates. If desired the inorganic sulfates can be separated from the sulfonates in any suitable way as, for example by extracting the sulfonates with alcohol.

The second class of materials constituting essential ingredients of the abscission retarding agents of the invention comprises naphthalene acetic acid, referred to commercially e. g. as alpha naphthalene, acetic acid, the ethyl and methyl esters thereof, and naphthaleneacetamide, or a mixture of one or more of such materials. Of these substances, in practice of the invention, I use naphthalene acetic acid preferably. The materials of this group may be made by known processes.

The abscission retarding agents of the invention are most conveniently applied to plant parts to be treated in the form of simple aqueous spray solutions made up by mixing certain limited amounts of the treating or retarding agents with water.

The invention includes the further features first, of certain proportioning, as between themselves, of the above described two classes of materials; and second, the concentrations of such materials in spray solutions as applied to the plant parts to be treated.

With regard to the quantities of the described sulfonates employed in practice of the invention, whether the sulfonate constituent is used in the form of the above indicated preferred mixture of alkyl phenol sulfonates and inorganic salt or in the form of alkyl phenol sulfonates alone, the amount of sulfonate employed is such that the spray solution as ready for application to the plant contains not less than 17 and not more than 45 grams, preferably about 34 grams of the said sulfonates, per 100 gallons of aqueous spray solution. In the case of the mixtures of alkyl phenol sulfonates and inorganic salt, the amount of mixture employed is chosen so that the spray solution contains not less than 42 grams and not more than 112 grams of such mixture. As to sulfonate-inorganic salt mixtures of this nature, the preferred amount is about 84 grams of mixture per 100 gallons of spray solution.

The amounts of naphthalene acetic acid and previously noted related compounds which may be used are small and vary over relatively narrow range. Quantities of these compounds are such that the spray solution as ready for application to the plant contains not less than one and not more than 2.5 grams per 100 gallons of aqueous spray solution. Preferred concentration of naphthalene acetic acid and related substances or mixtures thereof is about 2 grams per 100 gallons of spray solution.

It is advisable to include in the spray solution any suitable so-called spreading or sticking agent. For example, summer oil emulsions may be used in approximate quantities of one pint per 100 gallons of spray solution. Other stickers or spreaders such as caseinate, or wheat or soy bean flour may be employed to advantage.

In the practice of the invention, while the sulfonate constituents on the one hand and the naphthalene acetic acid or indicated related compounds on the other, and also the sticking or spreading agents if employed may be added separately or in any combination to water when making up the spray solutions, it is preferred to provide dry compositions containing the sulfonates and the naphthalene acetic acid or related compounds, and optionally a sticking or spreading agent. A further feature of the invention comprises provision of compositions, preferably in dry form, containing the sulfonates and naphthalene acetic acid or related substances in certain proportions which correspond in weight relationship with the proportions of sulfonates and naphthalene acetic acid or related compounds of the above described spray solutions.

With regard to formation of the preferred dry abscission retarding compositions of the invention, whether the sulfonate constituent is used in the form of the above indicated preferred mixture of alkyl phenol sulfonates and inorganic salt or in the form of alkyl phenol sulfonates alone, the sulfonate constituent and e. g. naphthalene acetic acid are dry mixed in such proportions that in the resulting composition sulfonates are present in amount not less than 7 and not more than 45 parts by weight to one part of naphthalene acetic acid. Preferably, the sulfonates and e. g. naphthalene acetic acid are incorporated in proportions of about 17 parts by weight of sulfonate to one part by weight of naphthalene acetic acid. In the case of use of the described mixtures of alkyl phenol sulfonates and inorganic salt, the amounts of such sulfonate-inorganic salt mixtures and e. g. naphthalene acetic acid are chosen so that the result-

ing composition contains not less than 17 and not more than 112 parts by weight of such sulfonate-inorganic salt mixtures to one part by weight of naphthalene acetic acid, the preferred proportioning in this situation being about 42 parts by weight of sulfonate-inorganic salt mixtures to one part by weight of naphthalene acetic acid. Hence, whether the abscission retarding compositions of the invention contain only the sulfonates and the naphthalene acetic acid or related compounds, or contain these two classes of materials in admixture with spreading or sticking agents, it will be understood that these compositions contain the sulfonate and e. g. naphthalene acetic acid constituents in the weight relations just specified.

Ordinarily it is preferred to include sticking and/or spreading agents in the compositions of the invention. Although quantities of sticking or spreading agents or both are quite variable such quantities are usually selected so that when a given amount of dry sulfonate-naphthalene acetic acid-sticking or spreading agent composition is added to 100 gallons of water the resulting spray solution contains sulfonate and naphthalene acetic acid or related compounds in the concentrations previously described. For example, when using the above indicated preferred mixture of alkyl phenol sulfonates and inorganic salt on the one hand and naphthalene acetic acid on the other as the effective abscission retarding agents, a composition containing (a) sulfonate-inorganic salt mixture, (b) naphthalene acetic acid, and (c) a spreader or sticker may be made up by incorporating sulfonate-inorganic salt mixture and naphthalene acetic acid in a weight relation of about 42 to one along with such quantity of sticker or spreader that when about 224 grams of the resulting dry composite mixture is added to 100 gallons of water, the spray solution obtained contains about 84 grams of the sulfonate-inorganic salt mixture and about 2 grams of naphthalene acetic acid. Hence, in this instance the dry composition added to 100 gallons of water contains by weight about 37.5 per cent sulfonate-inorganic salt mixture, about 0.88 per cent naphthalene acetic acid, the balance being sticking or spreading agent or both.

The abscission retarding agents of the invention are applied to the plants to be treated at a time shortly before abscission of the parts is to be expected. Particular time of application of the retarding agents is variable and dependent upon factors such as the nature of the subject treated whether bud, leaf, fruit or vegetable; climatic conditions; time interval before the retarding agents become effective; and the subsequent time interval within which the retarding agents function as such. While no hard and fast rule can be stated with respect to proper time of spraying a particular plant, generally speaking, experience shows that the agents of the invention ordinarily become effective as retarding agents within about 2 to 5 days from time of application, and then retain their abscission retarding efficacy ordinarily over a period of about 10 to 20 days. Hence, the retarding agents are sprayed on at a time as late as possible prior to expected abscission, due consideration being given to the time interval elapsing before the retarding agents become effective as such. Thus, in the case of apples, where the normal harvest period covers for instance 14 days, I find that effective results, comparable

with those indicated in the subsequently detailed examples, may be obtained where the retarding agents are applied from about 2 to 4 days prior to the time that first substantial abscission of apples is expected. Ordinarily a single spraying with the retarding agent concentrations described adequately covers an abscission and harvest period. More than one spraying is not recommended since field work indications are that multiple spray applications decrease efficiency.

The following examples show the abscission retarding properties of the compositions of the invention.

In all examples mentioned herein, the sticking and spreading agent employed in the spray solutions was a material consisting of 40% milk powder, 20% starch paste, 20% bentonite, and 20% clay, and the sulfonate was a material composed of about 60% by weight of sodium sulfate and about 40% by weight of a mixture of alkyl phenol sulfonates containing between 12 and 19 carbon atoms in the alkyl groups, which alkyl groups were derived from kerosene.

A spray solution was made up by adding to 100 gallons of water 166 grams of spreader, 56 grams of the above sulfonate-sodium sulfate retarding agent, and 2 grams of naphthalene acetic acid. The resulting solution was sprayed onto Williams variety apple trees 5 days prior to the time abscission was expected and 11 days prior to the day counts were made, i. e. completion of harvest. The drop from unsprayed check trees was 59.5%, and in the case of the sprayed trees, drop was only 3.7%. In another instance, the same spray solution was used, but Stayman variety trees were sprayed 4 days prior to the time abscission was expected and 12 days prior to the day counts were made. Fruit drop from unsprayed trees was 30%, and 12.7% from the sprayed trees.

In a second series of tests, a spray solution was made up by adding to 100 gallons of water 138 grams of spreader, 84 grams of the above sulfonate-sodium sulfate material, and 2 grams of naphthalene acetic acid. Two groups of Red Delicious variety apple trees were sprayed 4 days before abscission was expected. In one group, unsprayed trees showed an average per cent drop of 21.2, as compared with average per cent drop of 9.6 in the case of the sprayed trees. In the other group, in the unsprayed trees average per cent drop was 15.5 as compared with 5.8 for the sprayed trees.

In a third series of tests, the same spray solution was used as in the above second series. Skinner variety apples, Bellflower variety apples, and two groups of Bartlett pears were sprayed, and in the respective instances per cent drop was reduced 81.3, 93, 66.4 and 79.2 per cent as compared with the per cent drop of the check trees.

At a certain State experimental station, a spray solution was made up by adding to 100 gallons of water 138 grams of spreader, 84 grams of the above sulfonate-sodium sulfate material, and 2 grams of naphthalene acetic acid. A second spray solution was made up by adding to 100 gallons of water 69 grams of spreader, 42 grams of the above sulfonate-sodium sulfate material, and one gram of naphthalene acetic acid. Williams variety apples were sprayed, and in the case of trees sprayed with the first solution, per cent fruit drop was 6.9, and per cent fruit drop from the trees sprayed with the second solution

was 6.3. Per cent fruit drop from unsprayed check trees was 26.2.

In further tests, a spray solution was made up by adding to 100 gallons of water 138 grams of spreader, 84 grams of the above sulfonate-sodium sulfate material, and 2 grams of naphthalene acetic acid. Results were as follows:

Variety of apples	Per cent fruit drop	
	from sprayed trees	from unsprayed check trees
Transparent.....	8.7	21.0
Do.....	16.5	48.7
Williams.....	5.7	26.0
Do.....	6.5	41.0
Do.....	15.0	38.5
Dutchess.....	7.4	23.0
Do.....	7.0	22.3

My discoveries with respect to the abscission retarding properties of the herein described alkyl phenol sulfonates per se constitute the subject matter of my co-pending application Serial No. 440,755, filed April 27, 1942, now U. S. P. 2,322,409 of June 22, 1943.

I claim:

1. The method of retarding abscission of a part of a growing plant comprising treating the plant, shortly before the time abscission of the part is anticipated, with an aqueous solution containing, per 100 gallons thereof, (A) not less than 17 and not more than 45 grams of water-soluble alkyl phenol sulfonate containing 10 to 30 carbon atoms in the alkyl group, and (B) not less than one and not more than 2.5 grams of material of the group consisting of naphthalene acetic acid, the ethyl and methyl esters thereof, and naphthaleneacetamide.

2. The method of retarding abscission of a part of a growing plant comprising treating the plant, shortly before the time abscission of the part is anticipated, with an aqueous solution containing, per 100 gallons thereof, (A) not less than 17 and not more than 45 grams of water-soluble alkali metal salt of an alkyl phenol sulfonate containing 12 to 23 carbon atoms in the alkyl group, which alkyl group is derived from a petroleum distillate, and (B) not less than one and not more than 2.5 grams of naphthalene acetic acid.

3. The method of retarding abscission of a part of a growing plant comprising treating the plant, shortly before the time abscission of the part is anticipated, with an aqueous solution containing, per 100 gallons thereof, (A) about 34 grams of water-soluble alkali metal salt of an alkyl phenol sulfonate containing 12 to 19 carbon atoms in the alkyl group, which alkyl group is derived from kerosene, and (B) about 2 grams of naphthalene acetic acid.

4. The method of retarding abscission of a part of a growing plant comprising treating the plant, shortly before the time abscission of the part is anticipated, with an aqueous solution containing, per 100 gallons thereof, (A) not less than 17 and not more than 45 grams of water-soluble long chain alkyl phenol sulfonate, and (B) not less than one and not more than 2.5 grams of material of the group consisting of naphthalene acetic acid, the ethyl and methyl esters thereof, and naphthaleneacetamide.

5. A composition of matter containing (A) water-soluble alkyl phenol sulfonate containing 10 to 30 carbon atoms in the alkyl group, and (B) material of the group consisting of naphtha-

lene acetic acid, the ethyl and methyl esters thereof, and naphthaleneacetamide, said material (A) being present in amount not less than 7 and not more than 45 parts by weight to one part by weight of material (B).

6. A composition of matter containing water-soluble alkali metal salt of an alkyl phenol sulfonate containing 12 to 19 carbon atoms in the alkyl group which alkyl group is derived from kerosene, and naphthalene acetic acid, said sulfonate being present in amount not less than 7 and not more than 45 parts by weight to one part by weight of naphthalene acetic acid.

7. A composition of matter containing water-soluble alkali metal salt of an alkyl phenol sul-

fonate containing 12 to 19 carbon atoms in the alkyl group, which alkyl group is derived from kerosene, and naphthalene acetic acid, said sulfonate being present in amount of about 17 parts by weight to one part by weight of naphthalene acetic acid.

8. A composition of matter containing (A) water-soluble long chain alkyl phenol sulfonate, and (B) material of the group consisting of naphthalene acetic acid, the ethyl and methyl esters thereof, and naphthaleneacetamide, said material (A) being present in amount not less than 7 and not more than 45 parts by weight to one part by weight of material (B).

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